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**MEMO**

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From:  
Michael J. Erickson, PE, ARCADIS

Date:  
November 15, 2012

ARCADIS Project No.:  
B0064530.0003.00907

Subject:

Former Plainwell Impoundment and Plainwell No. 2 Dam Area Fall 2012 Bank Repair  
Plan Technical Memorandum – Revised November 2012

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On October 15, 2012, ARCADIS, on behalf of Georgia-Pacific, LLC (Georgia-Pacific), submitted a technical memorandum describing bank maintenance activities to be performed during the 2012 construction season in Removal Area 6B and the Western Channel of the Former Plainwell Impoundment and Removal Area 3A of the Plainwell No. 2 Dam Area. An additional area, Former Plainwell Impoundment Removal Area 4A, was identified by Paul Bucholtz of Michigan Department of Environmental Quality (MDEQ) on October 25, 2012 and communicated via an e-mail from United States Environmental Protection Agency (USEPA) on October 26, 2012. The October 15 technical memorandum has been revised to include Removal Area 4A.

On August 30, 2012, the fourth annual meeting with state and federal Trustees (Trustees) was held to discuss the results of the 2012 bank monitoring activities for the former Plainwell Impoundment Time-Critical Removal Action (TCRA) and Plainwell No. 2 Dam Area TCRA project areas. Meeting attendees included Garry Griffith of Georgia-Pacific, Steve Garbaciak of Anchor QEA LLC, Anthony Esposito, Eric Hritsuk, and EJ Suardini of ARCADIS, Ramon Mendoza of USEPA, Sharon Hanshue and Mark Mills of the Michigan Department of Natural Resources (MDNR), Judy Alfano, Paul Bucholtz, and Nick Dawson of

MDEQ, and Lisa Williams of the United States Fish and Wildlife Service (USFWS). Follow-up site visits were held on September 19, 2012 and October 25, 2012 and follow-up calls were held on September 17, 2012 and October 4, 2012 to discuss bank areas potentially requiring maintenance in 2012. ARCADIS, on behalf of Georgia-Pacific, has prepared this memorandum to describe the bank maintenance activities that will be implemented during the 2012 construction season.

## Site Background

An annual monitoring program is being carried out in the former Plainwell Impoundment (Figure 1) and Plainwell No. 2 Dam Area (Figure 2) to observe and document various characteristics of the floodplains and river banks after the completion of two TCRAs, performed from 2007 to 2010. The monitoring program includes visual inspections, a topographic survey (used to develop bank profiles), an assessment of the Bank Erosion Hazard Index (BEHI) ratings for the restored banks (to compare to bank conditions observed in prior years), woody vegetation survival monitoring, and an evaluation of percent ground cover and invasive weed presence. The *Former Plainwell Impoundment Time-Critical Removal Action and Plainwell No. 2 Dam Area Spring Bank Conditions Monitoring Report* (2012 BCMR; ARCADIS 2012a) documents the results of this monitoring program and was submitted to the Trustees on August 17, 2012.

Per the Administrative Settlement Agreement and Order on Consent for Removal Action (AOC) for the former Plainwell Impoundment, Docket No. V-W-07-C-863, dated February 21, 2007 (USEPA 2007), and for the Plainwell No. 2 Dam Area, Docket No. V-W-09-C-925 (USEPA 2009), bank monitoring is required by Georgia-Pacific annually at each site for a period of three years. The three-year monitoring period started following the issuance of a Notice of Completion of Work at each site by USEPA. In the former Plainwell Impoundment, the Notice of Completion of Work was issued March 30, 2010; therefore the monitoring period will end on March 30, 2013. A monitoring report was prepared for the former Plainwell Impoundment in 2009, after construction activities were completed, but before the Notice of Completion of Work was issued. In the Plainwell No. 2 Dam Area, the Notice of Completion of Work was issued March 1, 2011; therefore the monitoring period will end on March 1, 2014.

## Location of Bank Repair Areas

During the August 30, 2012, September 19, 2012, and October 25, 2012 site walks and September 17, 2012 and October 4, 2012 conference calls, six areas were identified by the Trustees as requiring repair. Four of the areas are addressed in this memo:

1. Former Plainwell Impoundment Western Channel (Figure 3)
2. Former Plainwell Impoundment Removal Area 4A (Figure 4)
3. Former Plainwell Impoundment Removal Area 6B (Figure 5)
4. Plainwell No. 2 Dam Area Removal Area 3A (Figure 6)

The design for bank repairs in each area is described in the next section.

The other two areas, Former Plainwell Impoundment Removal Areas 7, 8, and 9B and Removal Area 10A, are still under discussion with the Trustees and will be addressed in a separate Technical Memorandum.

## Conceptual Design of Bank Repair Areas

### Former Plainwell Impoundment Western Channel

During the August 30, 2012 and September 19, 2012 site walks, approximately 50 linear feet (ft) and 10 vertical ft of exposed geotextile fabric was observed on the south bank of the Western Channel downstream of the former Plainwell Dam (Figure 3). The geotextile was placed underneath the rock used for bank erosion protection as part of the TCRA. The exposed geotextile indicates that rock placed in this area has shifted towards the toe of slope, exposing the fabric, or that rock was not initially placed in this area since it was underwater at the time of construction and confirmation of placement of the intended amount and thickness of material over the complete extent of the area was difficult. This area is located immediately downstream of the Western Channel and is subject to the highest water velocities observed in the former Plainwell Impoundment.

The October 3, 2012 letter titled *Hydraulic Modeling Near Former Plainwell Dam at the Allied Paper, Inc. /Portage Creek/Kalamazoo River Superfund Site Time-Critical Removal Action near Plainwell, Michigan* (Hydraulic Modeling Letter; ARCADIS 2012b) was prepared to evaluate whether erosive forces on the banks exceed those anticipated during TCRA design.

According to the Former Plainwell Impoundment Design Report (ARCADIS BBL 2007), bank protection in the Western Channel was provided by a minimum 9-inch thick lift of rock with a mean diameter of 4 inches to the 2-year (prism-out) storm water elevation. The water elevation during a 2-year storm, based on the historical channel bottom elevation (prism-out), was selected as the upper limit of rock armoring for banks requiring armor (MDEQ 1998). This elevation occurs at a discharge of 3,845 cubic feet per second (cfs). The Hydraulic Modeling Letter concluded that flow conditions (i.e., channel bottom and wall shear stress and velocities) in the post-construction Western Channel are within the range predicted in the Former Plainwell Impoundment Design Report and, therefore, do not fall outside the design basis for the armor stone size. Rather, a known scour hole that formed during the September 2008 flood event when flow over the water control structure was influencing velocities in that area likely caused a small, local steepening of the bank angle that may have caused the rock to slide and expose the fabric. It is likely that the rock at this location settled after installation and exposed this small area of the geotextile fabric.

To repair this bank, the exposed geotextile fabric will be covered with approximately 20 cubic yards (cy) of an angular rip rap placed from the top of bank. The rock will be 8-inch mean diameter angular stone with a

maximum diameter of 18 inches. The plan view of the repair area and conceptual cross-section are shown on Figure 3. The bank slope is 3:1 and will not be altered by the repair.

Much smaller areas of geotextile fabric (<5 square feet) were exposed upstream of the Western Channel (Removal Area 13B). Existing river run rock in this area will be hand placed over the exposed fabric.

#### Former Plainwell Impoundment Removal Area 4A

Approximately 500 ft of bank in Removal Area 4A (River Station 55+00 to 60+00; Figure 4) have been monitored since 2009 and have exhibited signs of continuing erosion. Removal Area 4A is located on the north bank, immediately upstream of the US-131 Bridge. According to the Former Plainwell Impoundment Design Report (ARCADIS BBL 2007), the area was not expected to be subject to erosional forces requiring rock-based armoring following material removal and revegetation activities. Recent site visits noted that the bank vegetation in this area is well established.

Materials that were submerged immediately following excavation appear to have eroded since the completion of the TCRA, which increased the sheer stress before vegetation could become established on the bank. The erosion has the potential to expose polychlorinated biphenyl (PCB)-containing residual materials. The conditions causing erosion of the bank in Removal Area 4A do not appear likely to change in the near-term, so an increase in bank protection is needed. The primary objective of enhanced bank protection is to stop the erosion of the bank to maintain the remaining buffer between the river and bank material that was not excavated as a part of the TCRA.

The exposed bank needs to be covered with clean material to prevent contact between the river and the exposed residuals. The bank can then be armored with stone to the prism-out 2-year storm water elevation (discharge of 3,845 cfs) to prevent erosion of the clean material.

Similar to the 2008 repair performed in Removal Area 7, a rock launching toe will be placed in the channel to isolate the repair area from the flow of the river. Dimensions of the launching toe will be determined in the field based on observed field conditions. Imported fill (180 cy) will be placed behind the rock launching toe at a stable slope. It should be noted that the bank will not necessarily be re-built to its former post-construction dimensions. The bank repair design criteria are to isolate the exposed residuals from the river and to stabilize the bank slope to prevent future erosion. The imported fill will isolate the exposed residuals, and the rock armoring will prevent future erosion of the repaired bank. Therefore, the full 30-foot buffer is no longer warranted. After the fill is placed, the rock launching toe will be laid back on the newly formed bank. Additional rock will be added if necessary in order to bring the top of rock elevation up to the prism-out 2-year storm water elevation (discharge of 3,845 cfs).

As recommended in MDEQ guidance (MDEQ 1998), a non-woven geotextile fabric (7,300 square feet [sf]) will be installed on the imported fill slope prior to rock placement to protect against erosion behind the rock. The rock will be a mixture of 8-inch mean diameter angular stone with a maximum diameter of 18 inches and 6-inch mean diameter rounded stone with a maximum diameter of 12 inches. The local supply of the rounded stone used in the Former Plainwell Impoundment TCRA is limited. To the extent feasible based on available supply, the angular stone will be installed to the necessary thickness and elevation to create a stable slope below the prism-out median water elevation, and the rounded stone will be installed in a minimum 12-inch lift above the prism-out median water elevation to improve the aesthetics. If a stable river bed is encountered at the toe of slope, the rock will be placed on the bed and graded to the prism-out 2-year storm water elevation. If a stable bed is not encountered at the toe of slope, the rock protection will be keyed in below the bed to a depth of approximately 1 ft to protect against bank undercutting.

Transects T-3N and T-12N, surveyed as part of the 2012 BCMR (ARCADIS 2012a), are located in this bank repair area. The geometry of transect T-12N more closely resembles the eroded condition the bank repair is designed to address; therefore the bank conditions at transect T-12N were used for conceptual design. Bank geometry throughout the entire 500-ft bank repair area may vary. Approximately 200 cy of rock will be placed in the 500-ft repair area as shown on the plan view and cross-section included on Figure 4. The as-built geometry of the bank was a 3:1 slope. The bank repair will restore this geometry to the extent practical, and the final slope of the bank will be no steeper than 2:1. This volume estimate is based on one cross-section (T-12N in the 2012 BCMR) and is subject to change based on field conditions.

Installation of imported fill, rock, and geotextile fabric is expected to be completed in 2012. Rock and imported fill will be placed using a long reach excavator situated on the top of bank.

Areas landward of the repair disturbed by construction activities will be revegetated with Zone 3 Upland Seed mix following the repair. Following seeding, exposed portions of the bank will be covered with erosion control fabric to further protect the bank until vegetation becomes established. Rock will be placed to the 2-year storm elevation, leaving minimal area requiring re-vegetation. Furthermore, disturbance of existing vegetation will be minimized to the extent practical by stationing repair equipment landward of the vegetated bank areas, so seeding and/or installation of erosion control blanket may not be warranted.

#### Former Plainwell Impoundment Removal Area 6B

Approximately 500 ft of bank in Removal Area 6B (Figure 5; River Stations 43+50 to 48+00) have been monitored since 2009 and have exhibited signs of continuing erosion. Removal Area 6B is located on the south bank, immediately downstream of the US-131 Bridge. According to the Former Plainwell Impoundment Design Report (ARCADIS BBL 2007), the area was not expected to be subject to erosional forces requiring rock-based armoring following material removal and revegetation activities. Recent site visits noted that the bank vegetation in this area is well established.

Channel flow is being directed toward the south bank at this location by a mid-channel bar that has established downstream of the bridge. Prior to the TCRA, two islands were present south of the center of the Kalamazoo River, immediately downstream of the US-131 Bridge. Both islands were removed as a part of the TCRA. However, two new islands (gravel bars) have formed in the southern half of the channel downstream of the US-131 Bridge since completion of the TCRA. The new islands are not located in the same locations as the islands removed during the TCRA. The bridge and islands appear to divert water flow towards the banks in a manner that was not anticipated during TCRA design. The conditions causing erosion of the bank in Removal Area 6B do not appear likely to change in the near-term, so an increase in bank protection is needed. The primary objective of enhanced bank protection is to stop the erosion of the bank to maintain the remaining buffer between the river and bank material that was not excavated as a part of the TCRA.

Armoring the bank with stone was concluded to be the best option to address this eroding bank. Therefore, rock armoring will be installed in Removal Area 6B from the toe of slope to the prism-out 2-year storm water elevation (discharge of 3,845 cfs).

As recommended in MDEQ guidance (MDEQ 1998), a non-woven geotextile fabric (9,200 sf) will be installed prior to rock placement to protect against erosion behind the rock. The rock will be a mixture of 8-inch mean diameter angular stone with a maximum diameter of 18 inches and 6-inch mean diameter rounded stone with a maximum diameter of 12 inches, to the extent feasible based on available supply. If a stable river bed is encountered at the toe of slope, the rock will be placed on the bed and graded to the prism-out 2-year storm water elevation. If a stable bed is not encountered at the toe of slope, the rock protection will be keyed in below the bed to a depth of approximately 1 ft to protect against bank undercutting.

Transect T-5S, surveyed as part of the 2012 BCMR (ARCADIS 2012a), is the only survey transect located in this bank repair area. Therefore the bank conditions at T-5S have been used for conceptual design, but bank geometry throughout the entire 500-ft bank repair area may vary. Approximately 330 cy of rock will be placed in the 500-ft repair area as shown on the plan view and cross-section included on Figure 5. The as-built geometry of the bank was a 3:1 slope. The bank repair will restore this geometry to the extent practical, and the final slope of the bank will be no steeper than 2:1. This volume estimate is based on one cross-section (T-5S in the 2012 BCMR) and is subject to change based on field conditions.

Rock will be pre-washed prior to installation to minimize turbidity concerns and will be clean material from a virgin source. Therefore, use of a turbidity curtain is not warranted. Installation of rock and geotextile fabric is expected to be completed in 2012. Rock will be placed using a long reach excavator situated on the top of bank between Removal Area 6B and Upland Area 6B1 (Figure 5). This location is beyond the original excavation/restoration footprint and will protect existing vegetation to the extent practical. Willow trees growing in the area may be cut to a height of no less than 2 ft so that equipment situated at the top

of bank can reach over existing vegetation to access the slope for repair. Willow trees left at this height are expected to re-sprout.

If exposed banks occur landward of the rock repair disturbed by construction activities they will be seeded with Zone 3 Upland Seed mix and covered with erosion control fabric following the repair. Rock will be placed to the 2-year storm elevation, leaving minimal area requiring re-vegetation. Furthermore, existing vegetation will be protected to the extent practical, so seeding and/or installation of erosion control blanket may not be warranted.

Live willow stakes will be installed in 2013 above the prism-out 2-year storm water elevation to support bank stability as woody roots develop and to increase the habitat quality of the floodplain by providing woody habitat. Live staking and incorporation of root wads in the bank is a common practice used to enhance habitat quality and increase bank stability (Fischenich 2001).

#### Plainwell No. 2 Dam Area Removal Area 3A

As observed during the August 30, 2012 site walk, approximately 150 ft of bank in Removal Area 3A (Figure 6; River Stations 208+50 to 210+00) is showing signs of having lost bank material and having developed an increased bank angle, which may jeopardize the stability of the bank, should any substantial further losses occur. Removal Area 3A is located at the downstream end of the outer (north) bank of a channel meander. Vegetation density and root depth in this area decreased from 2011 to 2012, resulting from and/or contributing to the increased potential for bank erosion. According to the Plainwell No. 2 Dam Area Design Report (ARCADIS 2009), this area was not expected to be subject to erosional forces requiring rock armoring following removal and revegetation activities.

The observed erosion is related to unanticipated hydraulic forces on the banks that necessitate armoring. Rock toe protection was installed immediately upstream of the observed erosion. Prior to material removal, the bank naturally cut north, away from the main flow of the river at the point of erosion. The existing rock toe protection immediately upstream deflects the water velocity into the downstream un-rocked bank where the erosion was observed. The conditions causing erosion of the bank in Removal Area 3A are not likely to change in the near-term, so enhanced protection of the bank is needed. The primary objective of increased bank protection is to stop the erosion of the bank to maintain the remaining buffer between the river and bank material that was not excavated as a part of the TCRA.

The rock toe protection installed upstream of this bank repair location will be extended approximately 150 ft downstream to form a smooth, consistent toe of slope on the outside of the meander. Toe protection will extend from the toe of the restored bank to the median flow elevation, as modeled in the Plainwell No. 2 Dam Area Design Report (ARCADIS 2009). This elevation occurs at a discharge of 950 cfs. Rock toe protection to this elevation will usually be underwater and not visible except during drought conditions and would allow bank access by semi-aquatic wildlife species that forage along the bank. In addition, a coir log



will be installed at the interface of the top of the toe protection at the median water elevation. The coir log will provide additional energy dissipation and erosion protection at the waterline until bank vegetation establishes enough to provide long-term bank stability. The coir log will be 9 to 12 inches in diameter and secured with stakes and twine lashing as necessary to adequately secure the coir log. A well stabilized toe will prevent general widening of the channel, although some slope adjustment to the bank between the median water level and the top of bank may occur.

As recommended in MDEQ guidance (MDEQ 1998), a non-woven geotextile fabric (1,600 sf) will be installed prior to rock placement to protect against erosion behind the rock. The rock will be mixture of 8-inch mean diameter angular stone with a maximum diameter of 18 inches and 6-inch mean diameter rounded stone with a maximum diameter of 12 inches, to the extent feasible based on available supply. If a stable river bed is encountered at the toe of slope, the rock will be placed on the bed and graded to the median flow elevation. If a stable bed is not encountered at the toe of slope, the rock protection will be keyed in below the bed to a depth of 1 ft to protect against bank undercutting.

Transect T-4, surveyed as of the 2012 BCMR (ARCADIS 2012a), is the only survey transect in this bank repair area. Therefore, the bank conditions at T-4 have been used for conceptual design, but actual bank geometry throughout the entire 150-ft bank repair area may vary. The as-built geometry of the bank was a 3:1 slope. The bank repair will restore this geometry to the extent practical, and the final slope of the bank will be no steeper than 2:1. Approximately 40 cy of rock will be placed in the 150-ft repair area as shown on the plan view and cross-section included on Figure 6. This volume estimate is based on one cross-section (T-4 in the 2012 BCMR) and is subject to change based on field conditions.

Vegetated areas landward of the rock repair disturbed by construction activities will be seeded with Floodplain Forest Seed Mix following the repair. Following seeding, exposed portions of the bank will be covered with erosion control fabric to further protect the disturbed portions of the bank until vegetation becomes established. Previously planted trees and shrubs remain in Removal Area 3A as a part of the TCRA, and the bank is currently well-vegetated. The loss of bank material has primarily occurred near the current water elevation, which has been below the median water level for much of 2012. Rock placed to the median water level will tie into existing woody vegetation, which helps stabilize the bank. Since woody vegetation is present, installation of live willow stakes are not required.

## Implementation

Once the repairs described above are approved by the Trustees, the repairs will be performed in the remainder of the 2012 construction season.



## **Attachments**

Figure 1 – Former Plainwell Impoundment Site Location Map

Figure 2 – Plainwell No. 2 Dam Area Site Location Map

Figure 3 – Former Plainwell Impoundment Western Channel Proposed Bank Erosion Repair Plan and Cross-Section

Figure 4 – Former Plainwell Impoundment Removal Area 4A Proposed Bank Erosion Repair Plan and Cross-Section

Figure 5 – Former Plainwell Impoundment Removal Area 6B Proposed Bank Erosion Repair Plan and Cross-Section

Figure 6 – Plainwell No. 2 Dam Removal Area 3A Proposed Bank Erosion Repair Plan and Cross-Section

## **References**

ARCADIS. 2009. Plainwell No. 2 Dam Area Time-Critical Removal Action Design Report. Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. July.

ARCADIS 2012a. Former Plainwell Impoundment Time-Critical Removal Action and Plainwell No. 2 Dam Area Spring Bank Conditions Monitoring Report. August.

ARCADIS 2012b. Hydraulic Modeling Near Former Plainwell Dam at the Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site Time-Critical Removal Action near Plainwell, Michigan. October.

ARCADIS BBL. 2007. Former Plainwell Impoundment Time-Critical Removal Action Design Report. Kalamazoo River Study Group. Allied Paper, Inc./Portage Creek/Kalamazoo River Superfund Site. February.

Fischenich, C. 2001. Stability Thresholds for Stream Restoration Materials, EMRRP Technical Notes Collection (ERDC TNEMRRP- SR-29), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

MDEQ. 1998. Guidebook of Best Management Practices for Michigan Watersheds. Surface Water Quality Division.

USEPA. 2007. Administrative Order on Consent for Removal Action (AOC or Order) for the Allied Paper Inc./Portage Creek/Kalamazoo River Superfund Site (Docket No. V-W-07-C-863). February.

USEPA. 2009. Administrative Order on Consent for Removal Action (AOC or Order) for the Allied Paper Inc./Portage Creek/Kalamazoo River Superfund Site (Docket No. V-W-09-C-925). June.

ARCADIS

**Attachments**

CITY: SYRACUS DIV/GROUP: 14/ENV DB: KLS PM: SDG LTR: ONE-OFF-REF-  
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 PLOTSETUP: 18 (LMS TECH) PAGES: 1  
 PLOTTED: 11/15/2012 11:27 AM BY: SAMIOS, ALEX



REFERENCE: USGS QUADS., 7.5 MIN. SERIES, DRG TOPOGRAPHIC MAP - ALLEGAN COUNTY, KALAMAZOO MICHIGAN.

0 2000' 4000'  
 Approximate Scale: 1" = 2000'



GEORGIA-PACIFIC LLC  
 ALLIED PAPER, INC./PORTAGE CREEK/  
 KALAMAZOO RIVER SUPERFUND SITE  
**FORMER PLAINWELL IMPOUNDMENT AND PLAINWELL NO. 2 DAM  
 AREA FALL 2012 BANK REPAIR PLAN TECHNICAL MEMORANDUM -  
 REVISED NOVEMBER 2012**

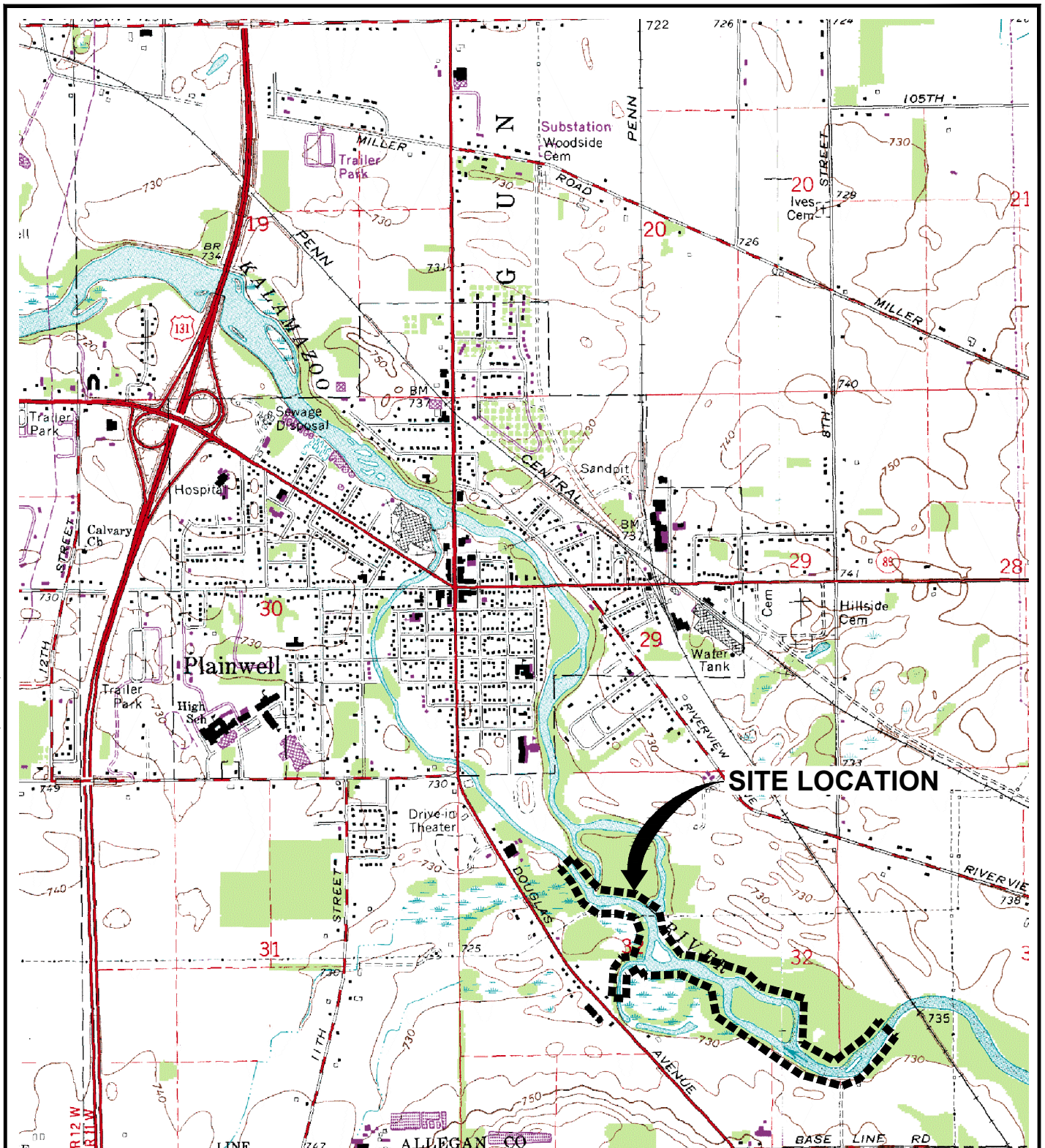
## FORMER PLAINWELL IMPOUNDMENT SITE LOCATION MAP



FIGURE  
**1**



CITY:SYRACUSE DIV:GROUP:ENV/CAD DB:A SAMIOS PMS:GARBACIAK LVR:ON-\*,OFF-\*,REF\*  
G:\ENV\CAD\STRACUSE\ACT\B064530\030\090\DWG\BANK REPAIR\64530\01.DWG LAYOUT: 2  
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REFERENCE: USGS QUADS., 7.5 MIN. SERIES, DRG TOPOGRAPHIC MAP - ALLEGAN COUNTY, KALAMAZOO MICHIGAN.

0 2000' 4000'

Approximate Scale: 1" = 2000'



AREA  
LOCATION

MICHIGAN

GEORGIA-PACIFIC LLC  
ALLIED PAPER, INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE

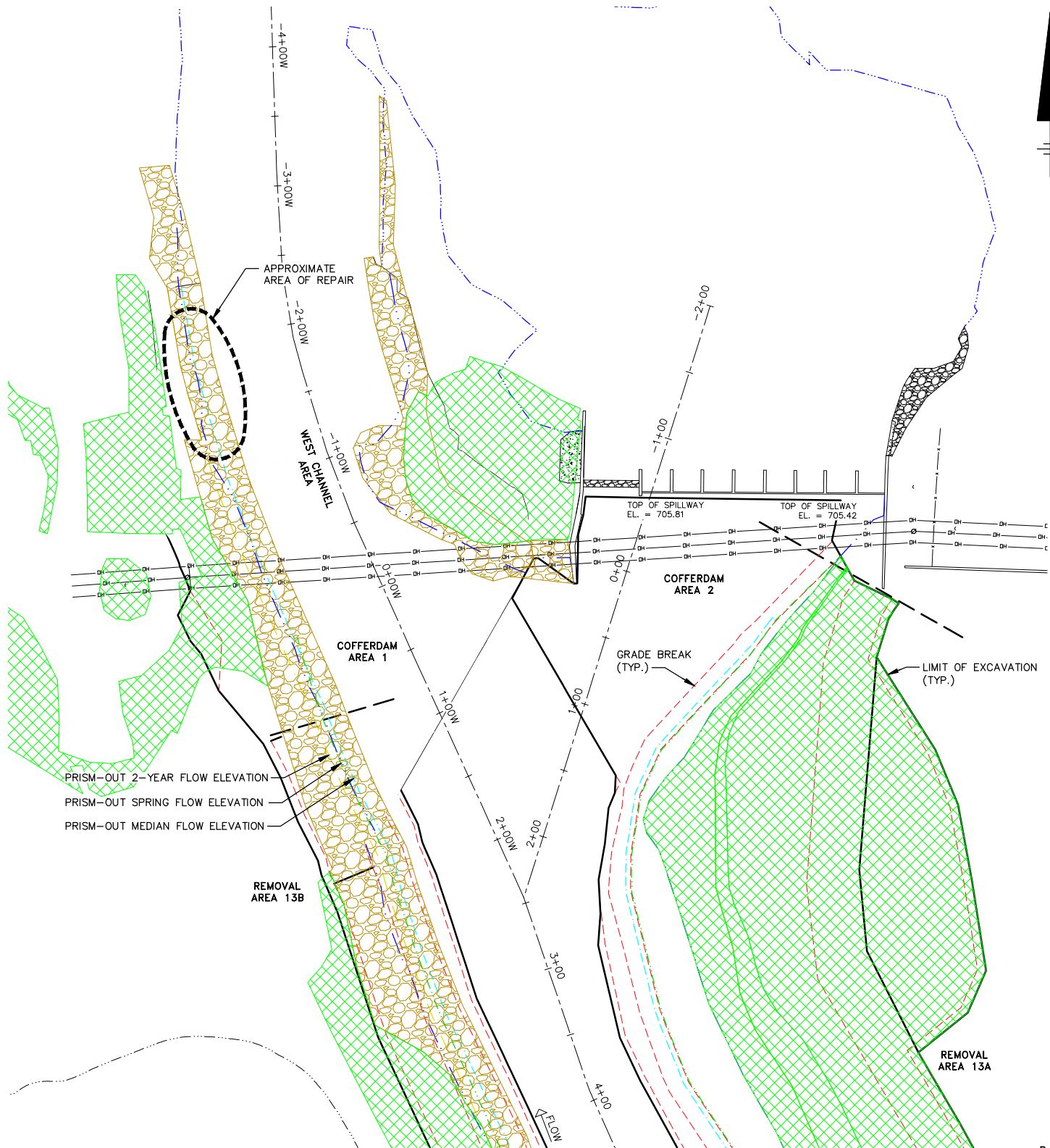
**FORMER PLAINWELL IMPOUNDMENT AND PLAINWELL NO. 2 DAM  
AREA FALL 2012 BANK REPAIR PLAN TECHNICAL MEMORANDUM  
- REVISED NOVEMBER 2012**

## PLAINWELL NO. 2 DAM AREA SITE LOCATION MAP



FIGURE

2



PLAN VIEW

0 50' 100'

GRAPHIC SCALE

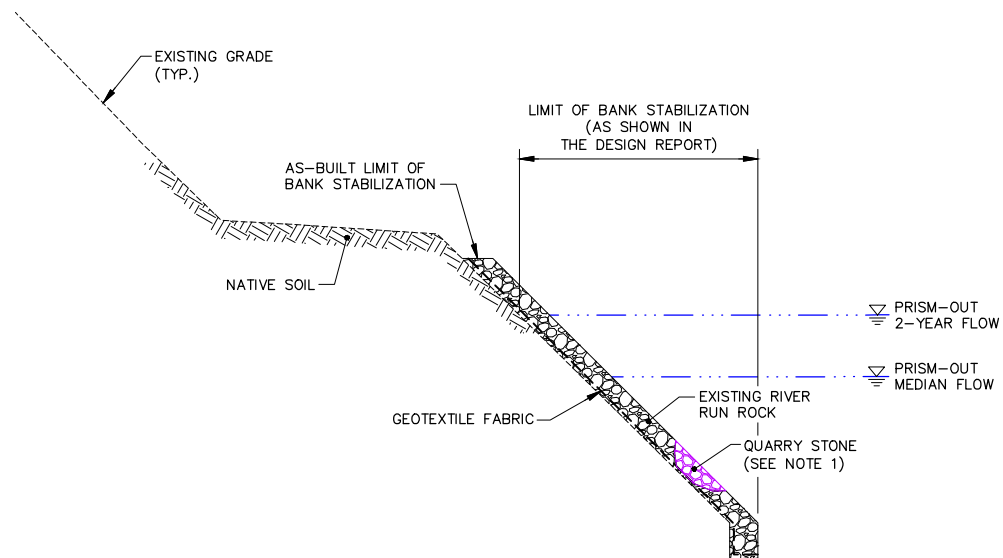
LEGEND:

- 1+00W STATION POINT (IN HUNDREDS OF FEET)
- +— KALAMAZOO RIVER CENTERLINE AND STATION LINE
- PRE-CONSTRUCTION WATER LINE
- - - APPROX. LIMIT OF REMOVAL AREA
- EXISTING VEGETATION
- EXISTING RIVER RUN ROCK

FLOW ELEVATION TABLE	
WEST CHANNEL	
STATION	PRISM-OUT 2-YEAR
-4+00W	701.6
-3+00W	702.1
-2+00W	702.3
-1+00W	702.5
0+00W	702.7
1+00W	702.9
2+00W	703.1

BASEMAP NOTES:

- BASEMAP TOPOGRAPHY WITHIN "APPROXIMATE LIMIT OF FIELD SURVEY" IS BASED ON FIELD SURVEY POINT DATA OBTAINED BY BBL IN SEPTEMBER 2003, AND PREIN & NEWHOF IN JULY, AUGUST, AND SEPTEMBER 2006. VERTICAL DATUM FOR ALL FIELD SURVEYS AND BENCHMARKS IS NGVD 29. LIMITS OF INDIVIDUAL FIELD SURVEYS ARE NOT SHOWN FOR CLARITY. SOME INTERPOLATION MAY EXIST BETWEEN INDIVIDUAL FIELD SURVEYS. BASEMAP TOPOGRAPHY OUTSIDE "APPROXIMATE LIMIT OF FIELD SURVEY" IS BASED ON CONTOUR INFORMATION OBTAINED FROM THE ALLEGAN COUNTY GIS DATABASE, DATED APRIL 2004. VERTICAL DATUM FOR AERIAL BASEMAP TOPOGRAPHY IS NAVD 88. CONVERSION BETWEEN VERTICAL DATUMS WITHIN VICINITY OF PROJECT SITE IS AS FOLLOWS: [NAVD 88] + 0.44 FT = [NGVD 29]. ALL ELEVATIONS SHOWN ARE IN FEET. HORIZONTAL DATUM FOR ALL SURVEY INFORMATION (I.E., FIELD AND AERIAL) IS STATE PLANE, NAD 83, MICHIGAN SOUTH ZONE (2113), INTERNATIONAL FEET.
- FLOW LIMITS SHOWN ON THIS DRAWING ARE BASED ON MODELING AS DESCRIBED IN SECTION 2.7 OF THE DESIGN REPORT. ACTUAL FLOW LIMITS VARIED THROUGHOUT WORK ACTIVITIES.



NOTE:

- QUARRY STONE SHALL BE 8-INCH MEAN DIAMETER ANGULAR STONE WITH A MAXIMUM DIAMETER OF 18-INCHES.

TYPICAL REPAIR SECTION

NOT TO SCALE  
(3X VERTICAL EXAGGERATION)

GEORGIA-PACIFIC LLC  
ALLIED PAPER INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE  
**FORMER PLAINWELL IMPOUNDMENT AND PLAINWELL NO. 2 DAM  
AREA FALL 2012 BANK REPAIR PLAN TECHNICAL MEMORANDUM -  
REVISED NOVEMBER 2012**  
**FORMER PLAINWELL IMPOUNDMENT  
WESTERN CHANNEL  
PROPOSED BANK EROSION REPAIR  
PLAN AND CROSS SECTION**





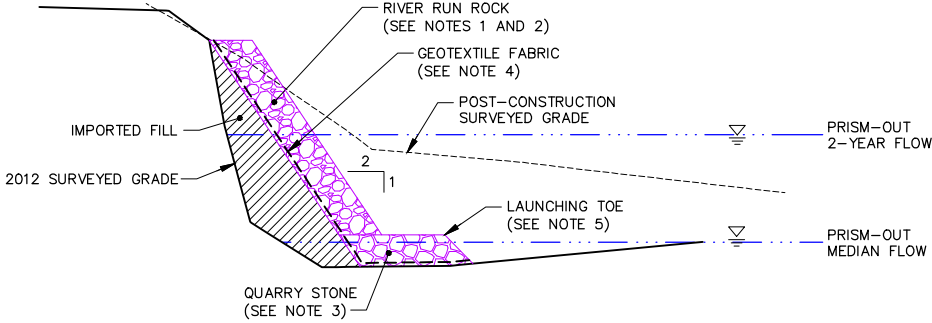


**LEGEND:**

- 60+00 STATION POINT (IN HUNDREDS OF FEET)
- KALAMAZOO RIVER CENTERLINE AND STATION LINE
- 710 ELEVATION CONTOUR
- APPROX. LIMIT OF FIELD SURVEY
- APPROX. LIMIT OF REMOVAL AREA
- PRE-CONSTRUCTION WATER LINE
- EXISTING VEGETATION
- EXISTING RIVER RUN ROCK
- ROCK

FLOW ELEVATION TABLE		
STATION	PRISM-OUT MED	PRISM-OUT 2-YEAR
54+00	708.9	711.1
55+00	709.0	711.2
56+00	709.1	711.3
57+00	709.2	711.4
58+00	709.4	711.6
59+00	709.5	711.7
60+00	709.7	711.8

- BASEMAP NOTES:**
- BASEMAP TOPOGRAPHY WITHIN "APPROXIMATE LIMIT OF FIELD SURVEY" IS BASED ON FIELD SURVEY POINT DATA OBTAINED BY BBL IN SEPTEMBER 2003, AND PREIN & NEUHOFF IN JULY, AUGUST, AND SEPTEMBER 2006. VERTICAL DATUM FOR ALL FIELD SURVEYS AND BENCHMARKS IS NGVD 29. LIMITS OF INDIVIDUAL FIELD SURVEYS ARE NOT SHOWN FOR CLARITY. SOME INTERPOLATION MAY EXIST BETWEEN INDIVIDUAL FIELD SURVEYS. BASEMAP TOPOGRAPHY OUTSIDE "APPROXIMATE LIMIT OF FIELD SURVEY" IS BASED ON CONTOUR INFORMATION OBTAINED FROM THE ALLEGAN COUNTY GIS DATABASE, DATED APRIL 2004. VERTICAL DATUM FOR AERIAL BASEMAP TOPOGRAPHY IS NAVD 88. CONVERSION BETWEEN VERTICAL DATUMS WITHIN VICINITY OF PROJECT SITE IS AS FOLLOWS: [NAVD 88] + 0.44 FT = [NGVD 29]. ALL ELEVATIONS SHOWN ARE IN FEET. HORIZONTAL DATUM FOR ALL SURVEY INFORMATION (I.E., FIELD AND AERIAL) IS STATE PLANE, NAD 83, MICHIGAN SOUTH ZONE (2113), INTERNATIONAL FEET.
  - FLOW LIMITS SHOWN ON THIS DRAWING ARE BASED ON MODELING AS DESCRIBED IN SECTION 2.7 OF THE DESIGN REPORT. ACTUAL FLOW LIMITS VARIED THROUGHOUT WORK ACTIVITIES.

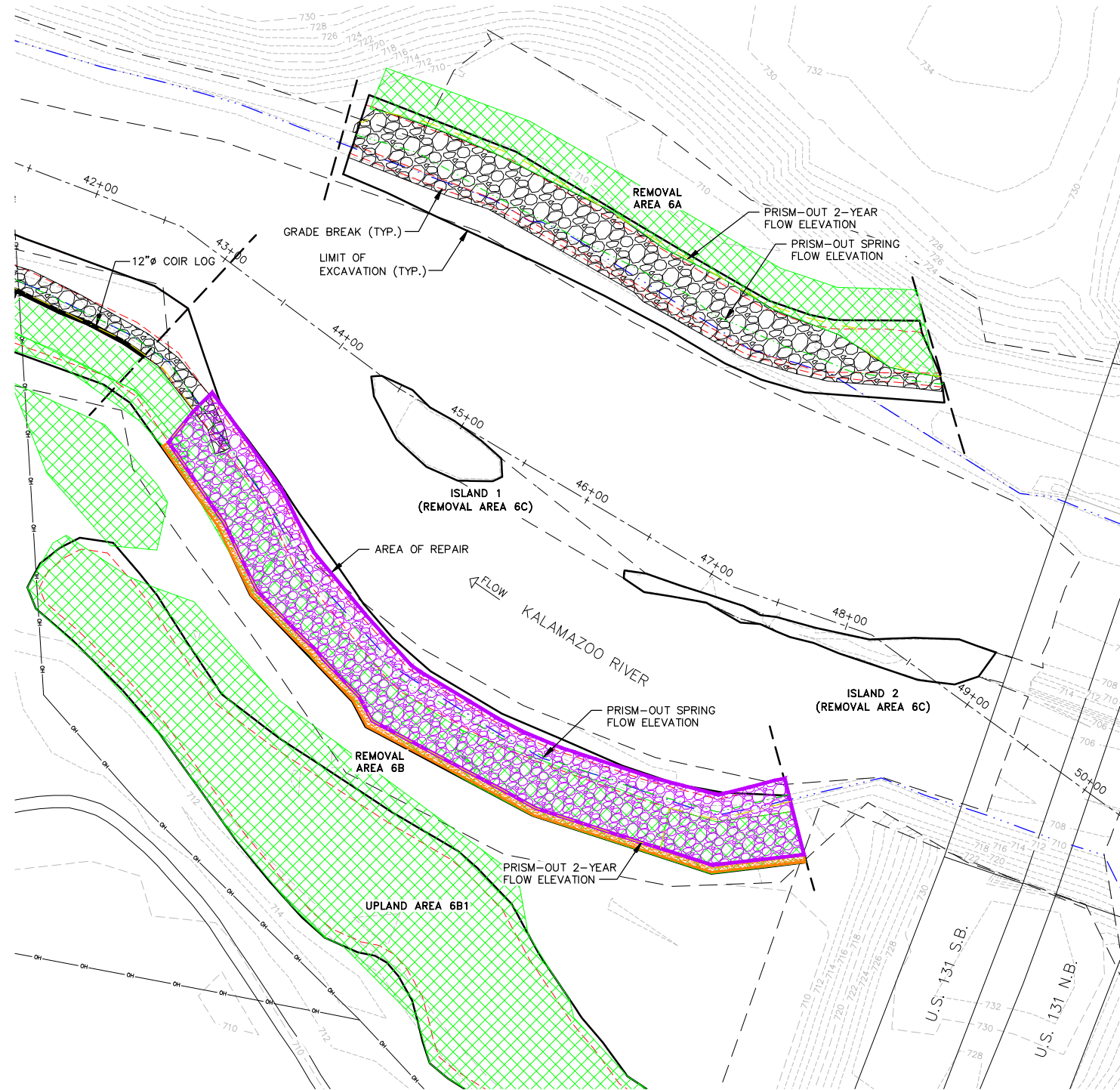


- NOTES:**
- AREA VISIBLE ABOVE THE WATER LINE SHALL BE TOP-DRESSED WITH RIVER RUN ROCK TO THE EXTENT PRACTICAL BASED ON LOCAL SUPPLY.
  - RIVER RUN ROCK SHALL GENERALLY BE 6-INCH MEAN DIAMETER ROUNDED STONE WITH A MAXIMUM DIAMETER OF 9 INCHES.
  - QUARRY STONE SHALL BE 8-INCH MEAN DIAMETER ANGULAR STONE WITH A MAXIMUM DIAMETER OF 18-INCHES.
  - GEOTEXTILE SHALL BE MIRAFI FILTERWEAVE 700, OR EQUIVALENT.
  - LAUNCHING TOE SHALL BE CONSTRUCTED TO ISOLATE THE FILL PLACEMENT AREA FROM THE FLOW OF THE RIVER. DIMENSIONS SHALL BE DETERMINED IN THE FIELD BASED ON OBSERVED FIELD CONDITIONS.

**TYPICAL REPAIR SECTION**  
NOT TO SCALE  
(3X VERTICAL EXAGGERATION)

GEORGIA-PACIFIC LLC  
ALLIED PAPER INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE  
**FORMER PLAINWELL IMPOUNDMENT AND PLAINWELL NO. 2 DAM  
AREA FALL 2012 BANK REPAIR PLAN TECHNICAL MEMORANDUM -  
REVISED NOVEMBER 2012**  
**FORMER PLAINWELL IMPOUNDMENT  
REMOVAL AREA 4A  
PROPOSED BANK EROSION REPAIR  
PLAN AND CROSS SECTION**





**PLAN VIEW**  
0 50' 100'  
GRAPHIC SCALE

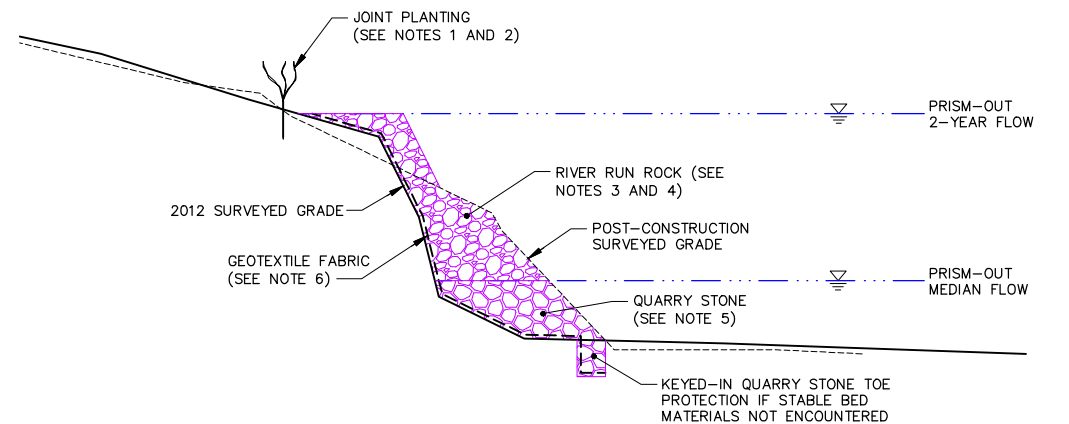
**LEGEND:**

- 60+00 STATION POINT (IN HUNDREDS OF FEET)
- KALAMAZOO RIVER CENTERLINE AND STATION LINE
- ELEVATION CONTOUR
- APPROX. LIMIT OF FIELD SURVEY
- APPROX. LIMIT OF REMOVAL AREA
- PRE-CONSTRUCTION WATER LINE
- EXISTING VEGETATION
- EXISTING RIVER RUN ROCK
- ROCK
- LIVE WILLOW STAKES

FLOW ELEVATION TABLE		
STATION	PRISM-OUT MED	PRISM-OUT 2-YEAR
43+00	705.7	708.8
44+00	706.0	709.0
45+00	706.1	709.1
46+00	706.2	709.1
47+00	706.4	709.2
48+00	706.7	709.3
49+00	707.3	709.3

**BASEMAP NOTES:**

- BASEMAP TOPOGRAPHY WITHIN "APPROXIMATE LIMIT OF FIELD SURVEY" IS BASED ON FIELD SURVEY POINT DATA OBTAINED BY BBL IN SEPTEMBER 2003, AND PREIN & NEWHOF IN JULY, AUGUST, AND SEPTEMBER 2006. VERTICAL DATUM FOR ALL FIELD SURVEYS AND BENCHMARKS IS NGVD 29. LIMITS OF INDIVIDUAL FIELD SURVEYS ARE NOT SHOWN FOR CLARITY. SOME INTERPOLATION MAY EXIST BETWEEN INDIVIDUAL FIELD SURVEYS. BASEMAP TOPOGRAPHY OUTSIDE "APPROXIMATE LIMIT OF FIELD SURVEY" IS BASED ON CONTOUR INFORMATION OBTAINED FROM THE ALLEGAN COUNTY GIS DATABASE, DATED APRIL 2004. VERTICAL DATUM FOR AERIAL BASEMAP TOPOGRAPHY IS NAVD 88. CONVERSION BETWEEN VERTICAL DATUMS WITHIN VICINITY OF PROJECT SITE IS AS FOLLOWS: [NAVD 88] + 0.44 FT = [NGVD 29]. ALL ELEVATIONS SHOWN ARE IN FEET. HORIZONTAL DATUM FOR ALL SURVEY INFORMATION (I.E., FIELD AND AERIAL) IS STATE PLANE, NAD 83, MICHIGAN SOUTH ZONE (2113), INTERNATIONAL FEET.
- FLOW LIMITS SHOWN ON THIS DRAWING ARE BASED ON MODELING AS DESCRIBED IN SECTION 2.7 OF THE DESIGN REPORT. ACTUAL FLOW LIMITS VARIED THROUGHOUT WORK ACTIVITIES.



**NOTES:**

- LIVE WILLOW STAKES SHALL BE INSERTED INTO UNDERLYING SOIL IN TWO ROWS AT 5-FOOT SPACING ON-CENTER.
- LIVE STAKES SHALL BE DORMANT STEM CUTTINGS OF 1 TO 3 INCHES IN DIAMETER AT THE TOP AND AT LEAST 36 INCHES IN LENGTH. CUTTINGS SHALL HAVE CLEAN ANGLED CUTS AT THE BOTTOM AND FLAT CUTS AT THE TOP, WITHOUT SPLIT ENDS, AND SHALL HAVE AT LEAST TWO LIVE LATERAL BUDS ON THE PORTION OF THE STAKE THAT WILL BE ABOVE-GROUND. TRIM ANY LATERAL BRANCHES.
- AREA VISIBLE ABOVE THE WATER LINE SHALL BE TOP-DRESSED WITH RIVER RUN ROCK TO THE EXTENT PRACTICAL BASED ON LOCAL SUPPLY.
- RIVER RUN ROCK SHALL GENERALLY BE 6-INCH MEAN DIAMETER ROUNDED STONE WITH A MAXIMUM DIAMETER OF 9 INCHES.
- QUARRY STONE SHALL BE 8-INCH MEAN DIAMETER ANGULAR STONE WITH A MAXIMUM DIAMETER OF 18-INCHES.
- GEOTEXTILE SHALL BE MIRAFI FILTERWEAVE 700, OR EQUIVALENT.

**TYPICAL REPAIR SECTION**

NOT TO SCALE  
(3X VERTICAL EXAGGERATION)

GEORGIA-PACIFIC LLC  
ALLIED PAPER INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE  
**FORMER PLAINWELL IMPOUNDMENT AND PLAINWELL NO. 2 DAM  
AREA FALL 2012 BANK REPAIR PLAN TECHNICAL MEMORANDUM -  
REVISED NOVEMBER 2012**  
**FORMER PLAINWELL IMPOUNDMENT  
REMOVAL AREA 6B  
PROPOSED BANK EROSION REPAIR  
PLAN AND CROSS SECTION**

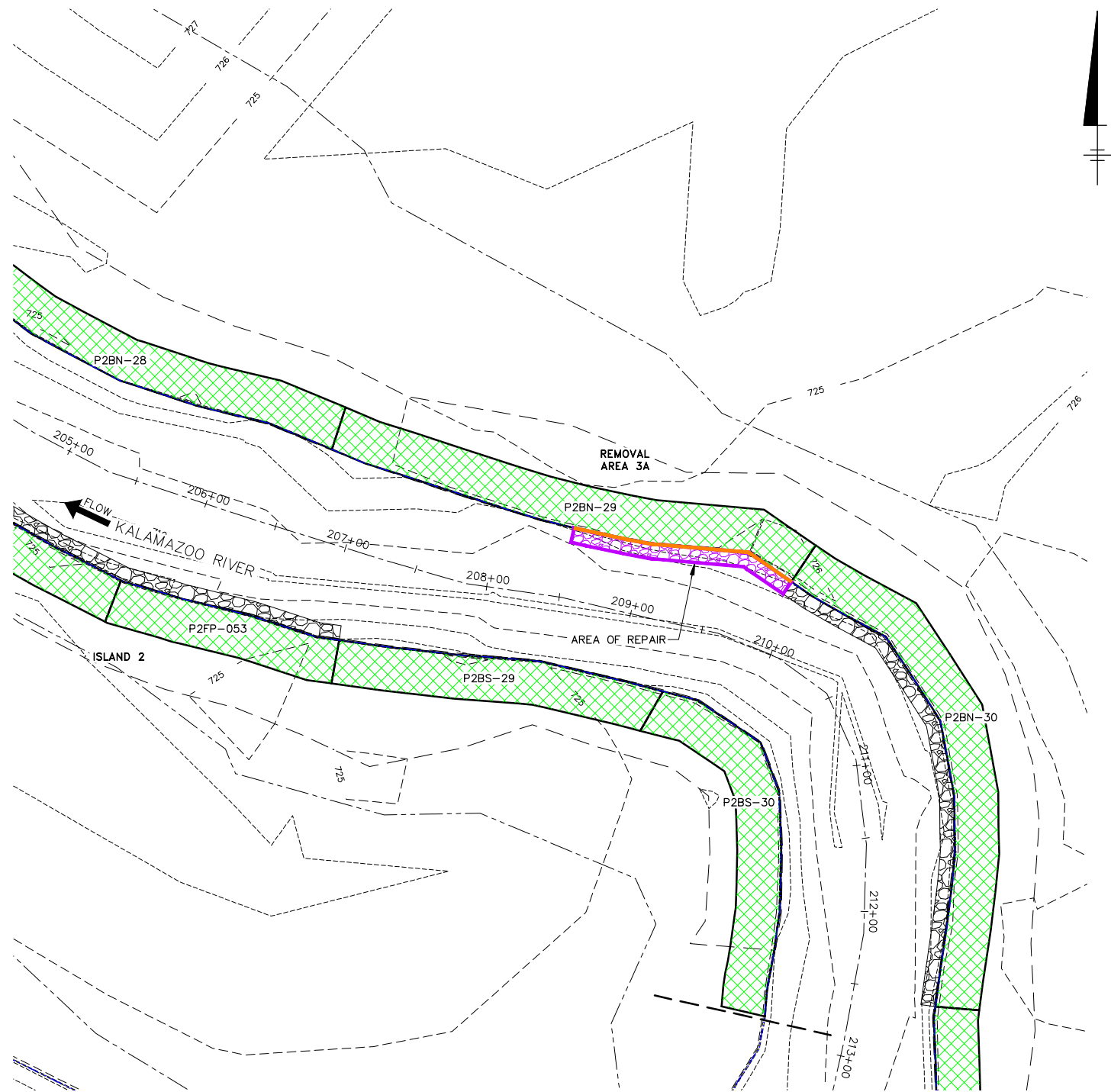




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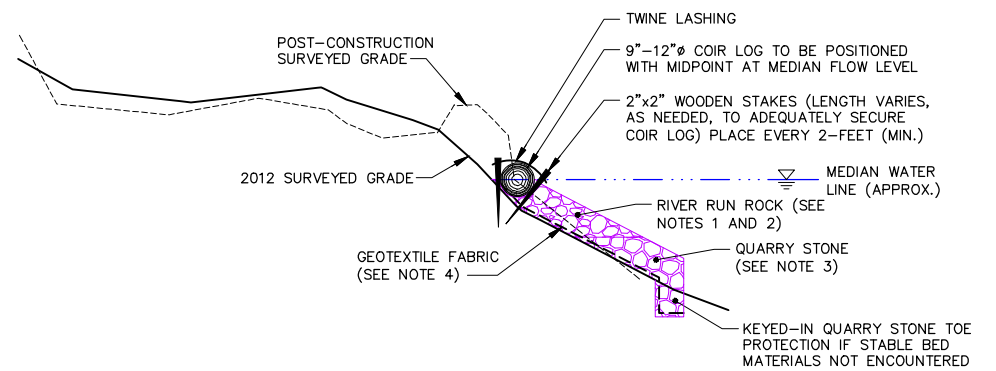
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**PLAN VIEW**  
0 50' 100'  
GRAPHIC SCALE

- LEGEND:**
- 209+00 STATION POINT (IN HUNDREDS OF FEET)
  - KALAMAZOO RIVER CENTERLINE AND STATION LINE
  - 725 ELEVATION CONTOUR
  - APPROX. LIMIT OF FIELD SURVEY
  - APPROX. LIMIT OF REMOVAL AREA
  - APPROX. MEDIAN WATER LINE
  - EXISTING VEGETATION
  - EXISTING RIVER RUN ROCK
  - ROCK
  - COIR LOG

- BASEMAP NOTES:**
- APPROXIMATE LIMITS OF FIELD-BASED SURVEY DELINEATES AREA WHERE TOPOGRAPHIC INFORMATION IS BASED ON SURVEY DATA COLLECTED DURING FIELD WORK IN 1993, 2000, 2007, AND 2008, WHICH INCLUDED SEDIMENT AND SOIL SAMPLE COLLECTION, TRANSECT SURVEYS, PROBING ACTIVITIES, AND DETAILED BANK SURVEY PERFORMED BY PREIN & NEWHOF APRIL THROUGH JUNE 2009. TOPOGRAPHIC INFORMATION OUTSIDE APPROXIMATE LIMITS OF FIELD-BASED SURVEY IS BASED ON AERIAL SURVEY INFORMATION PROVIDED BY AXIS GEOSPATIAL, LLC (JOB NUMBER: 8068NE, DATE FLOWN: DECEMBER 29, 2008, CONTOUR INTERVAL: 1 FOOT). HORIZONTAL DATUM FOR ALL SURVEY INFORMATION IS STATE PLANE, NAD 83, MICHIGAN SOUTH ZONE (2113), INTERNATIONAL FEET. VERTICAL DATUM IS U.S.G.S. NGVD 29. UNITS ARE U.S. SURVEY FEET.
  - APPROXIMATE MEDIAN WATER LINE BASED ON HYDRAULIC MODELING ANALYSIS. WATER LINE VARIED THROUGHOUT FIELD ACTIVITIES.



- NOTES:**
- AREA VISIBLE ABOVE THE WATER LINE SHALL BE TOP-DRESSED WITH RIVER RUN ROCK TO THE EXTENT PRACTICAL BASED ON LOCAL SUPPLY.
  - RIVER RUN ROCK SHALL GENERALLY BE 6-INCH MEAN DIAMETER ROUNDED STONE WITH A MAXIMUM DIAMETER OF 9 INCHES.
  - QUARRY STONE SHALL BE 8-INCH MEAN DIAMETER ANGULAR STONE WITH A MAXIMUM DIAMETER OF 18-INCHES.
  - GEOTEXTILE SHALL BE MIRAFI FILTERWEAVE 700, OR EQUIVALENT.

**TYPICAL REPAIR SECTION**  
NOT TO SCALE  
(3X VERTICAL EXAGGERATION)

GEORGIA-PACIFIC LLC  
ALLIED PAPER INC./PORTAGE CREEK/  
KALAMAZOO RIVER SUPERFUND SITE  
**FORMER PLAINWELL IMPOUNDMENT AND PLAINWELL NO. 2 DAM  
AREA FALL 2012 BANK REPAIR PLAN TECHNICAL MEMORANDUM -  
REVISED NOVEMBER 2012**

**PLAINWELL NO. 2 DAM  
REMOVAL AREA 3A  
PROPOSED BANK EROSION REPAIR  
PLAN AND CROSS SECTION**

FIGURE  
**6**